Some War Uses of Concrete

"Hard permanent roads and plenty of artillery win modern wars"

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"Cement is now one of the giant industries of America along with steel, automobiles and films. It is a factor in preparedness, an indispensable material in modern fortifications, gun emplacements and other necessary works."—CHICAGO EVENING POST.

Concrete in Peace and War

SO rapid have been the developments in building construction during the past few years that few perhaps stop to think how great a part concrete has played in this. Without portland cement many of the modern engineering structures which today stand as monuments to the engineers and contractors skill would not have been possible.

Concrete enters in some form into practically every class of building construction or engineering project. Country highways, bridges, city streets and alleys, factories, warehouses, sewerage plants and disposal systems, water supply works—every building project from the smallest structure on the farm to the largest in the city—is dependent upon concrete wholly or in part.

Whether in peace or in war, we must use concrete. Fire-safeness and sanitation of our army cantonments will depend upon how extensively and consistently concrete has been used in these camp developments.

Captain E. Z. Steever, U. S. Army, says: "No road is better than its weakest bridge." Concrete is the only bridge construction material that grows stronger as it grows older.

Old-time types of roads will not withstand the demands of modern traffic, which is largely made up of swiftly-moving automobiles and heavily-laden motor trucks. War's demands on highways are even greater than the demands of peace—pleasure and commercial traffic. Concrete roads have proven that with respect to first cost and cost of maintenance they are best adapted to the rapidly-increasing and diversified traffic of today.

In the following pages there are listed under topic heads, various references to uses of concrete particularly associated with the offensive and defensive needs of war. This bibliography has been compiled by the Library of the Portland Cement Association—a technical reference library specializing in the uses of cement in concrete construction. This library consists of standard texts, Government documents and technical periodicals. A special feature is the subject index to periodical material consisting of approximately 60,000 cards.

Librarians, engineers, contractors and others interested in the United States and Canada are invited to make use of this library for bibliographies pertaining to concrete and the cement industry. Write for references or telephone Franklin 1540. This service incurs no obligation.

PORTLAND CEMENT ASSOCIATION,
111 West Washington Street, Chicago

Armories

Ashland, Ore., state armory. Building constructed entirely of concrete. illus. Cement Era, Aug. 1914. v. 12, no. 8, p. 39.

Efficient methods in handling concrete in armory. Second Infantry Armory, Chicago, Ill. Features of armory construction; placing concrete drill hall floors. illus. Cement Era, May 1916. v. 14, no. 5, p. 63.

End framing for armory at University of Illinois. (Champaign) and some general features of this structure. Side walls constructed of 8″ terra cotta tiles. Concrete exterior finish applied with cement gun. illus. diagr. Engineering and Contracting, Feb. 17, 1915. v. 43, no. 7, p. 141-3.

Payne, W. A. Use of concrete in the new arsenal and armory, Hartford, Conn. Concrete foundations, reinforced concrete floor and roof and decorative concrete trimming. diagr. Connecticut Society of Civil Engineers, Proceedings, 1909, p. 103-14.

Reinforced concrete construction in the Hartford (Conn.), armory. Floors, roofs, columns and stairs built of reinforced concrete. illus. diagr. Engineering Record, Jan. 9, 1909. v. 59, no. 2, p. 46-9.

San Francisco armory. Armory for National Guard is constructed of reinforced concrete. illus. Dept. of Engineering, State of California, 3rd biennial report, 1912, p. 51-2.

Unique concrete blocks built by home-made traveler. First Cavalry Armory, Chicago, Ill. Drill hall and headhouse constructed with concrete blocks. Engineering Record, Dec. 30, 1916. v. 74, no. 27, p. 811.

Coast Defense

Concrete for defense works. Concrete used extensively by U. S. government in building battle commander's stations, fire-control observing stations, signal corps switch board rooms, power plants for searchlights and searchlight shelters. illus. Cement World, Dec. 1914. v. 8, no. 9, p. 70.

Concrete in sea-coast defense in U. S. Observation towers for battery commanders, entered by flights of reinforced concrete steps, either from the ground or from the gun floors. Constructed by U. S. army engineers at sea-coast fortifications. illus. Cement World, Nov. 1914. v. 8, no. 8, p. 12-3.

Ferro Concrete searchlight towers. Concrete tower built for British War Office on east coast of England. illus. diagr. Ferro-concrete, Nov. 1914. v. 6, no. 5, p. 180.

Lloyd-Davies, D. E. Harbor and coast-defense works at Alexandria, Egypt. Huge reinforced concrete caissons filled with concrete form one monolithic mass in construction of breakwater. illus. Concrete and Constructional Engineering, Jan. 1916. v. 11, no. 1, p. 41-4.

Dry Docks

Activity in Boston (Mass.), harbor work. Largest dry dock in world constructed of concrete at South Boston, 1200′ long. Engineering News, Nov. 11, 1915. v. 74, no. 20, p. 956.

America's dreadnaughts yards. Reinforced concrete docks at Mare Island, Cal. Concrete and Constructional Engineering, March 1916. v. 11, no. 3. p. 156.

New government dry dock at Lauzon, Quebec. Concrete walls line rock face of excavation and solid concrete walls of gravity type support earth fills. Dock is 1150′ in length. Canadian Engineering, Sept. 3, 1914. v. 27, no. 10, p. 389-92.

Rinker, H. S. Construction of dry dock no. 4, Brooklyn Navy Yard. Caisson-supported reinforced concrete dry dock 723′ long. First docking in the new dry dock was the "Utah," the largest vessel of the U. S. Navy. illus. Engineering News, July 25, 1912. v. 68, no. 4, p. 141-8.

Stanford, H. R.* Pearl Harbor dry dock. Island of Oahu, Hawaii. Description of peculiar construction difficulties and problems involved and military importance. Plans and methods finally adopted. illus. diagr. American Society of Civil Engineers. Transactions, Dec. 1916. v. 80, p. 223-37.

To build concrete shipways 990′ long at Fore River. Built to handle one of the new battle cruisers recently authorized by Congress. Over 12,000 cu. yd. of concrete will be required. Engineering News-Record, Apr. 19, 1917. v. 78, no. 3, p. 172.

Fortifications

"Cement was early adopted in fortification work. Now it is universally used, with steel and iron, in all such work. The parapets surrounding disappearing guns and breach-loading mortars are in every instance thickly faced with concrete, if they are not wholly constructed of the new material. The floors, ammunition rooms, runways, ramparts—everything is of cement and steel, mostly the former." Concrete and Constructional Engineering, July 1911.

Concrete as a factor in canal and coast defense. Description of concrete block powder magazines at the Panama Canal. Roofs made of concrete reinforced with old Belgian rails. "In concrete blocks the government officials have found a material which will even stop modern bullets. Concrete structures of Canal are so heavy that even modern explosives have not much chance against them." Concrete, March 1910. v. 10, no. 3, p. 66.

Concrete for fortification work in America. Power plant constructed of concrete. Concrete and Constructional Engineering, July, 1911. V. 6, no. 7, p. 537-9. Taken from Cement Age, Oct. 1910. v. 11, no. 4, p. 209-13.

Concrete fortification construction for gun battery defenses of the mouth of Columbia River, Oregon and Washington. Concrete gun battery at Ft. Stevens, Ore. diagr. Cement, Nov. 1902. v. 3, no. 5, p. 438-43.

Fortress of Heligoland. How concrete and steel have been employed by the Germans. Ferro-concrete, June 1915. v. 6, no. 12, p. 461-2.

Hall, C., and Howell, S. P. Magazines and thaw houses for explosives. Cement-mortar magazine erected by Bureau of Mines has capacity of 30,000 lb. of explosives and was built at a cost of $400. Cement-mortar thaw house with a capacity of 500 lb. recently built by Bureau of Mines for thawing large quantities of explosives cost $200. illus. diagr. U. S. Dept. of Interior, Bureau of Mines.

Harvey, W. F. Concrete's important part in the modern game of war. The wide use of concrete in fortification and battery construction. illus. Concrete, Oct. 1908. v. 8, no. 10, p. 21-4.

Isthmian Canal Commission, Reports. 1913 to date. 131,952.8 cu. yds. of concrete laid in 1913 in building fortifications at Panama Canal. Extensive use of concrete for gun and mortar batteries in 1914.

Reinforced concrete in fortifications. In 1886 reinforced concrete was used for first time in U. S. fortifications by Brig.-Gen. Black at Ft. Marion, St. Augustine, Fla. (From biographical sketch of Brig.-Gen. W. M. Black, Corps of Engineers, U. S. A.) Engineering Record, March 11, 1916. v. 73, no. 11, p. 367.

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*Corps of Civil Engineers, U. S. Navy; Chief of Bureau of Yards and Docks, Navy Department.

Reinforced-concrete torpedo-testing station in the Bay D'Hyeres, near Toulon, France. Structure is a large cellular concrete pier. The super-structure was built as a reinforced concrete caisson on land and towed under its own buoyancy about 20 miles to its permanent foundation. (Abstracted from paper by M. Michel-Schmidt in Memoireset Travaux de la Societe des Ingenieurs Civils de France, Bulletin, Jan. 1909, p. 18.) Engineering News, July 8, 1909. v. 62, no. 2, p. 36-8.

Rifle butts at Breedene, Ostend. The targets and bullet screens completed in 1910 for Belgium War Office are of reinforced concrete similar to retaining walls in design and range in height to 40′. Ferro-concrete, Dec. 1914. v. 6, no. 6, p. 210-11.

U. S. Army Engineers, Reports. 1914 to date. Contain interesting studies concerning the use of cement and concrete in fortification work along Atlantic and Pacific coasts.

Gun Emplacements

"There is something about concrete, whether it be its smooth, immaculate whiteness or what, that seems to typify strength, solidity, stability, and endurance, and the layman who stands, a simple spectator, while the great guns of our coast defenses, mounted in their spick and span concrete pits, are put through practice, sending their missiles far out to sea, gets a lesson in patriotism far and away beyond what the reading of volumes of books could give him." Cement World, Jan. 1913.

Car mounted gun reduces coast defense to engineering problem. Located along existing railways 400 concrete bases on which gun cars could be run and locked would protect Atlantic coast. Fixed concrete emplacements are cheaper than tracks and are favored by U. S. army officers and engineers. illus. Engineering News-Record, Apr. 26, 1914. v. 78, no. 4, p. 204-5.

Derrick shifts concrete chute in five minutes for battery emplacement. Methods of construction briefly described, Fort McArthur, Ohio. illus. Contractor, Apr. 13, 1917. v. 24, no. 8, p. 169.

Gun platform foundations. Concrete foundations for two-gun and mortar platforms 27½′ in diameter for eighth district coast artillery armory, New York, placed by sinking sectional concrete caissons. diagr. Engineering Record, June 13, 1914. v. 69, no. 24, p. 677.

Monster concrete gun pits. Describes briefly concrete gun emplacements. Cement World, Jan. 1913. v. 6, no. 10, p. 43.

Military Camps and Barracks

Aiken, R. Monolithic concrete wall buildings—methods, construction and cost. Concrete target abutments, barrack buildings and ammunition and gun house at Camp Logan, Ill. Rifle Range and Mess Hall at Camp Perry, Ohio, built by Aiken system. illus. National Association of Cement Users, Proceedings, 1909. v. 5, p. 83-105.

Beanfield, R. M. Half mile of concrete barracks. U. S. soldiers live in fireproof quarters on Corregidor, P. I., the Gibraltar of the Orient. Methods and materials used in the construction of the reinforced concrete barracks at Fort Mills in Manila Bay. illus. diagr. Concrete Cement Age, Oct. 1913. v. 3, no. 4, p. 164-7.

Concrete slabs for a military camp (England). A large part of the camp has been constructed with concrete slabs and blocks in combination with light steel work skeleton frame. Camp includes such buildings as officers' quarters, religious purposes huts, barrack huts, cook houses, bakeries, dining rooms, bath houses, guard houses, stables and post office. illus. Concrete and Constructional Engineering, June 1916. v. 11, no. 6, p. 310-7.

Hardman, R. C. Engineering methods of army post planning and design. "Fort Sill (Okla.), Fort Crockett (Texas), and posts near Honolulu are among the later ones in which reinforced concrete is largely employed." Engineering News, Apr. 13, 1916. v. 75, no. 15, p. 702-4.

Unit wall concrete building construction, Fort Crockett (Galveston), Texas. Thirty-one reinforced concrete buildings erected at post artillery 10 under Aiken system of flat wall construction. illus. Engineering News, June 27, 1912. v. 67, no. 26, p. 1205-6.

Huge Canadian air camp. At camp Borden, north of Toronto, 15 concrete sheds 120′ x 66′ have been built. (Abstracted from Flying, Apr. 1917.) American Society of Mechanical Engineers, Journal, May 1917. v. 39, no. 5, p. 456.

Marray, A. Father Time, concrete and the government. Reinforced concrete buildings at Fort McDowell, Angel Island, Cal., include post exchange, hospital, barracks and officers' quarters. illus. Cement World, Sept. 1912. v. 6, no. 6, p. 21-4.

Military Roads

"Roads rule the world, not kings nor congresses, not courts nor constables, not ships nor soldiers. The road is the only royal line in a democracy, the only legislature that never changes, the only court that never sleeps, the only army that never quits, the first aid to the redemption of any nation, the exodus from stagnation in any society, the call from savagery in any tribe, the high priest of prosperity, after the order of Malchisedec, without beginnings of days or end of life. The road is umpire in every war, and when the new map is made it simply pushes on its great campaign of help, hope, brotherhood, efficiency and peace." (Author Unknown).

"From the earliest times the soldier has been intimately associated with the making of roads. The school boy still struggles with the description of the roads built by the armies of Xerxes and Hannibal. The famous old paved Roman roads, remains of which are today found in many parts of Europe, some still in use, were essentially military roads, while the greatest soldier of modern times, Napoleon, was also one of the greatest road builders." Address delivered before American Road Congress, Atlantic City, Oct. 4, 1912, by Col. Spencer Cosby, Major, Corps of Engineers, U. S. Army. Professional Memoirs, 1914.

Bond, P. S. Battle tactics and the paved highway. Municipal Engineering, May 1916. v. 50, no. 5, p. 207-8.

Build dips in concrete roads instead of culverts. diagr. Concrete-Cement Age, Sept. 1913. v. 3, no. 3, p. 143.

Fries, A. A.* Value of permanent highways for national defense. "Take the case of the famous German drive toward Paris. By the swiftness of their mobilization and movements the Germans all but took Paris which was only saved by General Joffre's skillful use of automobiles and the fine roads around Paris." National Conference on Concrete Road Building, Proceedings, 1916, p. 36-43.

Hyde, A. P. S. Highway system as a military adjunct. Good Roads magazine, Dec. 2, 1916. new series, v. 12, no. 23, p. 226-7. Abstract of paper presented at Fall Convention (1916) of Washington County Engineers' Association at Tacoma, Washington.

Moorefield, C. H. and Voshell, J. T. Portland cement concrete pavements for country roads. U. S. Dept. of Agriculture, 1915. Bulletin no. 249.

Portland Cement Association,†
Build the Maintenance Into the Road.
Concrete Facts About Concrete Roads.
The Concrete Road (Speech by Edw. N. Hines).
Equipment for Concrete Road Construction.
Facts Everyone Should Know About Concrete Roads.
Concrete Highway Magazine, Jan. 1916 to date.
How to Maintain Concrete Roads, Streets and Alleys.
Specifications for Concrete Roads, Streets, Alleys and Concrete Paving Between Street Car Tracks.
Concrete Ships—A Possible Solution of the Shipping Problem.

*Major, Corps of Engineers, U. S. Army.
†These publications may be obtained free.

Some Interesting Types Of Bridges

"A reinforced concrete bridge at Soissons was blown up by the Germans in their retreat from that town, but, owing to the great strength and toughness of the material, it defied all attempts at complete destruction, such as was readily affected in the case of the other bridge at Soissons, which was of metal." Concrete and Constructional Engineering, Dec. 1915.

Bailey, E. P. Bridge built of assembled sections. A 690′ reinforced concrete bridge of 3-hinged arch-rib type, San Luis, Rey River, near Oceanside, Cal. illus. Cement World, June 1911. v. 5, no. 3, p. 50-2.

Beyers, C. A. Arroyo, Seco reinforced concrete bridge near Pasadena, Cal. Total length of 1,470′ consists of series of arches built on a curve. illus. Concrete, May 1916. v. 8, no. 5, p. 203-5.

Bridges and viaducts on the Multonomah County section of the Columbia River Highway. illus. Good Roads, Nov. 6, 1915. new series, v. 10, no. 19, p. 243-7.

Carver, G. P. Concrete viaducts on the Key West extension of the Florida East Coast Railway. Concrete construction consists of about 500-reinforced concrete segmental or semi-circular arches of from 45′ to 60′ span and has an entire length of about 6 miles. illus. diagr. Engineering Record, Oct. 20, 1906. v. 54, no. 16, p. 424-7.

Connecticut Avenue concrete bridge at Washington, D. C. illus. Engineering News, Mar. 26, 1908. v. 59, no. 13, p. 327-8.

Construction methods employed in building the Galveston (Texas) causeway. The causeway which has a total length of a little more than 2 miles is made up of 2,455′ concrete arch viaduct and concrete protected filled embankment. illus. diagr. Engineering Record, July 13, 1912. v. 66, no. 2, p. 41-3.

Emperger, F. von. Portable bridges for military roads and emergency bridges. Bowstring bridge built up of cast iron arch units enclosed in concrete. Concrete and Constructional Engineering, Jan. 1916. v. 11, no. 1, p. 35-40.

Ferguson, P. C. Truss bridge of separate units. Las Vegas, N. M., bridge of four 40′ reinforced concrete truss spans assembled from separately-molded units. illus. diagr. Cement World, Jan. 1915. v. 8, no. 10, p. 38-9.

French Broad River Bridge, Southern Railway (between Asheville and Craggy, N. C.) Reinforced concrete girder bridge 733′ 10″ long. illus. diagr. Engineering Record, Jan. 7, 1911. v. 63, no. 1, p. 12-3.

Good, F. A. Construction of concrete fords. illus. Concrete-Cement Age, Sept. 1913. v. 3, no. 3, p. 112-3.

Noyes, E. N. Construction of the concrete viaduct between Dallas and Oak Cliff, Texas. Methods used in building a girder and arch structure 6,562′ long. illus. diagr. Engineering Record, Nov. 9, 1912. v. 66, no. 19, p. 520-2.

Pitt River reinforced concrete arch bridge near Baird, Cal. illus. diagr. Engineering News, June 29, 1916. v. 75, no. 26, p. 1209-11.

Raschig, F. L. Concrete viaducts and bridges of Cincinnati, Ohio. illus. American Concrete Institute, Proceedings, 1916. v. 12, p. 120-31.

Simpson, C. W. Construction methods on the Tunkhannock and Martin's Creek viaducts, Lackawanna Railroad. illus. diagr. American Concrete Institute, Proceedings, 1916. v. 12, p. 100-12.

Sprague, N. S. Large reinforced concrete bridges in Pittsburgh, Pa. illus. Engineering Record, Dec. 21, 1912. v. 66, no. 25, p. 698-700.

Stone bridges in French battle area rapidly rebuilt. Masonry arches destroyed by army replaced by concrete arches without use of false work—Meurthe River bridge. "Cement, of course, can more readily be brought forward than any other structural material, and sand and gravel are local products, so that concrete, which can be made by unskilled labor, is doubly effective for such work." Engineering News-Record, May 10, 1917. v. 78, no. 6, p. 309-10.

Miscellaneous War Uses of Concrete

Bomb-Proof Shelters

Bomb-proof cellars to provide shelter during aerial attacks (Germany). Reinforced concrete slab ceiling. diagr. Concrete, May 1916. v. 8, no. 5, p. 198. Abstracted from Baumaterialien-Markt, Nov. 26, 1915.

Emperger, F. von. Splinter-proof shelters in the field. External walls and partitions are constructed of concrete. This structure will resist shrapnel and will not collapse completely when struck by shell. Concrete and Constructional Engineering, July 1916. v. 11, no. 7, p. 370-2. Abstracted from Beton and Eisen, no date.

Camp Sanitation

Commission of immigration and housing of California. Advisory pamphlet on camp sanitation and housing. Concrete incinerator for garbage and refuse disposal described. diagr. Chap. 6, p. 17-27.

Gorgas, W. C.* U. S. Army camp sanitation in Mexico. Cement used in improvised kitchen incinerator made by soldiers in camp. illus. diagr. Engineering Record, May 16, 1914. v. 69, no. 20, p. 548-50.

Incinerators

Reinforced concrete incinerator. illus. Concrete and Constructional Engineering, Jan. 1913. v. 8, no. 1, p. 57-8.

Water Supply

Woolley, Monroe. "Buried" military reservoir. Concrete reservoir of 2,000,000 gallon capacity constructed for a western coast defense garrison. illus. Cement World, Dec. 1911. v. 5, no. 9, p. 45-6.

Flag Poles

Corbett, A. E. The Y. M. C. A. Building, Manchester, Eng. The flagstaff 27′ high, 10″ diameter at base and 6″ at top, is of reinforced concrete cast solid. The Concrete Institute, Transactions and Notes, 1911. v. 3, p. 297.

Dobson, G. C.† Reinforced Concrete flag pole at Panama. Flagstaff at Balboa Heights has clear height of 70′ and is 8½″ in diameter at top and 17″ at base. Engineering News, Sept. 2, 1915. v. 74, no. 10, p. 452-3.

Hospitals

McColloch, R. A. Use of reinforced concrete for hospitals and similar structures. illus. National Association of Cement Users, Proceedings, 1911. v. 7, p. 328-43.

Underground concrete hospitals. Emergency hospitals of concrete have been successfully installed in mines of Pennsylvania. (A suggested use of concrete). illus. Rock Products, July 22, 1911. v. 11, no. 1, p. 56.

Some results of the cannon firing on buildings in Mexico. As a "result of ten days' cannonading on the reinforced concrete Y. M. C. A. Building, the exterior was badly pitted by the shots, but received comparatively little injury considering the heavy fire to which it was exposed." illus. Engineering News, May 8, 1913. v. 69, no. 19, p. 970-1.

Use of concrete on the battlefield. Russians took from enemy 1,000 concrete girders, 7,000,000 concrete cubes, etc. (London (?) Times report from Petrograd, no date). Concrete Constructional Engineering, July 1916. v. 11, no. 7, p. 388.

*Surgeon General, U. S. Army.
†Assistant Engineer, Permanent Building Division, Panama Canal.

Zeppelin bombs fail to wreck concrete building. "A bomb dropped on a roof of a modern building constructed of reinforced concrete with steel and concrete roof did no damage, while similar bombs practically caused the entire destruction of brick buildings in the same vicinity." Concrete, March 1916. v. 8, no. 3, p. 130.

Munition Factories

Aberthaw Construction Co., Boston. From Foundations to roof in 40 working days. Colt's Patent Fire Arms Manufacturing Company's concrete building, to take care of orders from the United States Government, built in forty days. (1916) pamphlet.

Prisons

Concrete naval prison. Prison at Navy Yard, Portsmouth, N. H., is a reinforced concrete building, providing quarters for 320 men under restraint. illus. Cement World, Aug. 15, 1914. v. 8, no. 5, p. 60-2.

Concrete prison building on Massachusetts State Farm. illus. Concrete, Jan. 1910. v. 10, no. 1, p. 28-9.

Concrete cell block in Pennsylvania prison. Cell block is 360′ long, 54′ wide and 34′ high, of reinforced concrete faced on exterior with cast concrete slabs. illus. Concrete, Jan. 1910. v. 10, no. 1, p. 30-1.

Most modern prison is of concrete. Minnesota prison at Stillwater surrounded by 3,000′ of concrete walls. Cells of solid concrete will house 1,000 prisoners. illus. Cement Era, May 1913. v. 11, no. 5, p. 41-3.

United States Government builds concrete block prison. Military prison at Fort Leavenworth, Kansas. illus. Concrete, May 1910. v. 10, no. 5, p. 55.

Residences

Bosworth, P. H. Concrete houses in war time. Cement World, Oct. 15, 1913. v. 7, no. 7, p. 33.

Sewage Disposal For Camps

Sewage works for military camp. Ripon, Eng., camp occupies area of about 1,080 acres and designed to provide accommodations for complete army corps of 42,000 men, with 10,000 horses and large military hospital, together with an infectious disease hospital. Two screening tanks, four deep and four long, subsidence tanks of concrete. Engineering Record, Jan. 15, 1916. v. 73, no. 3, p. 82-3.

Taylor, H. W. Sewage treatment works for Altamont (N. Y.) Y. M. C. A. camp. Concrete was extensively used in constructing the disposal tank plant, including small circular Imhoff tank designed to care for population of 200. Engineering News, Dec. 23, 1915. v. 74, no. 26, p. 1219-20.

War Ships

Armor plate for war ships; a new use for ferro-concrete. Tests conducted under direction of the Italian Naval Minister indicate the superiority of reinforced concrete over steel armor in resistance to artillery fire. diagr. Ferro-concrete, Apr. 1916. v. 6, no. 10, p. 366-7.

Concrete armor backing. Used successfully by Navy Yard in New York. About $30,000 was saved by substituting concrete for teakwood on the "Arizona." Concrete and Cement Age, Sept. 1915. v. 7, no. 3, p. 92.

Weber, Carl. New methods devised for building ships of concrete. Engineering Record, Dec. 23, 1916. v. 74, no. 26, p. 779-80.
Concrete Ships—A Possible Solution of the Shipping Problem.

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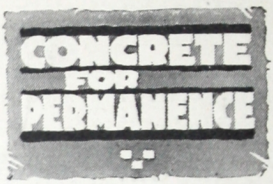

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